

Docket No. G2622-908496

Appl. No. 09/539,772

Preliminary Amendment filed with RCE Request

**AMENDMENTS TO THE SPECIFICATION:**

Please replace the specification with the following substitute specification showing changes made via strikethrough and underlining:

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**SYSTEM AND METHOD FOR INDEXING RECORDINGS OF OBSERVED TEST  
EVENTS AND ASSESSED PHENOMENA USING PRE-DEFINED MEASUREMENT  
ITEMS**

This application is a continuation in part of provisional patent application serial no. 60/127,194 on March 31, 1999, the disclosure of which is herein incorporated by reference.

This invention was supported ~~made~~ with a grant from the U.S. government which may have rights to the invention.

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**FIELD OF THE INVENTION**

~~The present invention relates to information processing systems and observation and assessment methods and operations, including the training and monitoring of interviewers or observers, quantitative and qualitative rating and assessment processes, and the storage and retrieval of recordings of interviews or observed events and, more particularly, to a system and method for indexing recordings of interviews or other observed events or phenomena by combining systematic use by an observer of pre-defined descriptive or quantitative measurement items with simultaneous digital recording to automatically generate indexes.~~

The present invention generally relates to information processing systems. More particularly, the invention is a data capture and access system that correlates data with recorded signals with an index based on pre-identified identifiers at the time of capture but allows later annotation or additional indexing without affecting the original index identifiers or the recorded signals. The invention specifically provides a method for indexing of digital recordings of events by use of pre-entered or pre-existing measurement items that serve as index information designators such as key words or labels. Such a method is particularly useful as those used in a systematic interview or assessment method.

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### DESCRIPTION OF THE PRIORRELATED ART

In Many events in the medical, legal, scientific, business, and education domains, among others, it is necessary to systematically observe and describe, assess, rate, or otherwise measure events or processes (i.e., phenomena). It is also useful to make recordings of these events and to be able to playback these recordings. For example, physicians may use audio, video, or electrophysiological recording of an interview, a physical examination, a diagnostic procedure, an operation, or autopsy, today are being digitally recorded. Physicians may record a physical examination, operation, or autopsy and may need to retrieve and examine specific parts of an annotate that recording at some later time for various purposes. Attorneys may carry out and to notes, observations, or other content in order to make a more complete record or draw previously unseen trends. Lawyers may seek to record a witness deposition and later playback sections of link that oral testimony in order to link the testimony to other to evidence (documentary, video, or testimony by other witnesses) in order to draw parallels, or highlight inconsistencies, or for other purposes. Social scientists apply systematic observation and rating methods to study society and culture. The frequency of such recordings, audio, video, or other, is likely to increase as their usefulness continues to grow. In general, the usefulness depends upon the purposes and value of retrieval and playback, the range of retrieval and playback functions, and how accurately and efficiently retrieval and playback can be carried out. Purposes include: thereby allowing for review of the assessor's conclusion or diagnoses, providing an educational or teaching tool to illustrate observation, assessment, and measurement techniques in general, creating teaching materials; monitoring teachers, trainees, and raters; allowing for review of the assessor's conclusion or diagnoses; supporting retrieval of multiple interviews, events, or segments of interviews or events for comparison and other study; reviewing an optimum assessment interview techniques, documenting the interview for legal and/or other purposes; and other similar and varied uses in many domains.

As a more detailed and prototypical example, medicine Medicine and public health are domains in which considerable effort has been devoted to the development of tools (e.g., questionnaires or assessment schedules and instruments) for conducting systematic assessment interviews and examinations. A main, The objective of these efforts has often been to improve the accuracy, reliability, and efficiency of a clinician's diagnosis of his/her patient.

Among medical disciplines, psychiatry researchers have perhaps allocated the most efforts to developing patient assessment methods and toolssaids. Examples of the types of

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~~assessment instruments that have been developed, which are composed of descriptor or quantitative assessment (i.e., measurement) items or questions, instruments developed include the Structured Clinical Interview for DSM (SCID), the Diagnostic Interview Schedule (DIS), the Composite International Diagnostic Interview (CIDI), the World Health Organization (WHO) International Personality Disorders Examination (IPDE), and the WHO Schedules for Clinical Assessment in Neuropsychiatry (SCAN). These tests have been standardized around sets of inquiries or measurement items. Measurement items typically are composed of 1) definition of a phenomenon of interest; 2) instructions regarding observation of the phenomenon; and 3) a quantitative rating scale. The scientific field of measurement, known as psychometrics, includes study of and methods pertaining to systematic and standardized observation, measurement, training, monitoring, and comparison. Psychometric issues of importance include efficiency, reliability (consistency), and validity (accuracy).~~ a core set of inquiries or directions.

~~The response to or rating of standardized questions, inquiries, or measurement items and instructions or directions is of interest for the assessor, both in terms of the assessment result~~ substantive response ~~as well as the behavior manifested in the delivery and of the assessment and in the response. As well as expressed symptoms, psychiatrists~~ Psychiatrists ~~may want to measure or rate the behavioral responses of patients, or may wish to observe and rate the actions of other psychiatrists in training. Cardiologists may want to measure physical responses to changes in applied stress, such as changes in the EKG readings during a cardiac stress test. Lawyers may seek to identify inconsistencies between witnesses to an accident using standardized questions. Similar examples are found in virtually every profession where a pattern of systematic observation and testing for response, and analysis of that the response, is used. In all these fields, analog or digital recordings of audio, video, physiologic, or other aspects of observed events are used to assist in these processes~~ is used.

~~However, most anyone who has participated in retrieving and organizing~~ reviewing ~~these interview or testing recorded materials for review and study~~ records ~~realizes that the retrieval and review process is usually tedious, often incomplete and inaccurate, and has vast room for improvement. What is needed for improved retrieval and management of audio, video, or other recorded materials are indexes that are meaningful, accurate, and easily generated, manipulated, and extended. Indeed, one of the most important features of any useful recording and retrieval~~ review process needs help and improvement. If there was an efficient way to index the video, audio or other type of recording when the interview was

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recorded, much time could be saved when later searching the records for particular information.

It is, therefore, an object of the present invention to provide a system and method for conducting, recording, playing back and editing or annotating digital recordings in audio, video, or other format.

Key to any useful recording system based on digital media is the ability to efficiently generate meaningful indexes for the recorded material. Such indexes would be especially valuable for structured or systematic information gathering processes in which professional or scientific standards are required and/or in which considerable efforts are made in training, quality control, and other administrative functions, e.g., a television interview based upon a list of questions, giving a patient are well suited for structured information gathering events that use a systematic question-and-answer method containing a set or list of standardized inquiries, e.g., a list of television interview questions, a health questionnaire, a clinical or research medical assessment, conducting a set of deposition, using questions, a list of actions to activate brain function in different ways, conducting focus groups, ethnographic research, or administering and a graded cardiac stress test, among others.

In the fields of medicine and health, the established means of recording structured assessments has generally been by use of analog audio or video tape recorders. Indexing, if used at all, has been generally through means such as length counters and manually added entries, or with hybrid combinations of tape recorders with microprocessor systems. This makes, This made the process of creating indexes tedious and often incomplete. In addition, even after indexes are created, the use of tape recorders means that the process of searching and playback remains slow and inefficient. Finally, creation of generally meaningful indexes has been problematic.

In the field of digital recording, many indexing schemes have been developed, ranging from low-level encoding to linking of text with video frames. Industry standard digital encoding methods such as the MPEG-2 (Society of Motion Picture Engineers) format, include channels for indexing based upon time code. However, most of these approaches generate index entries in a form not directly useful for retrieval, playback, and management, but rather provide basic mechanisms for supporting indexing. For example, one prior art

One system is known that uses computer voice-to-text processing to automatically generate words that are then used to index the source digital audio recording. Although of

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~~some-useful~~, it does not provide a more organized level of indexing, since many words will be used in many areas of a recording, and hence as such do not provide specific indexing to unique areas or segments of a recording. For indexing to be more useful, the ~~indexes or~~ index items should contain meaningful and unique information that is associated with ~~unique the recording locations or segments. Many location or segment. Any~~ indexing ~~methods~~method can support this, but it is generally tedious and inefficient to generate such index items manually.

Examples of prior art indexing systems include U.S. Pat. No. 4,841,387, which discloses an indexing system using a touchpad to correlate simultaneously recorded audio or video information to handwritten notes made on numbered sheets of paper manually placed on top of the touchpad. This system is simply a means for replay of recorded audio or video information through manual entry of sheet numbers and physical contact with the paper in the approximate area of the original handwritten note, to generate a touchpad signal that is used to access the correlation indexed recording. The system does not anticipate correlation of recordings with any information other than the position of handwritten notes and a page number, nor does it provide any other means of identifying, searching, or retrieving recorded materials, nor does it support psychometric and more general observation, measurement, retrieval, training, monitoring, or comparison functions and operations. In the professional and technical arenas, it is systematic as well as quick access to specific passages or segments of recorded material that determines a system's usefulness, which is not adequately provided by utilizing the position of handwritten notes for indexing.

European patent application publication EP 0 495 612 discloses an indexing system that connects manually entered computer notes to audio or video recordings, and permits the user to retrieve and play sections of a recording by selecting a note. The indexing is based upon spatial location and organization of a set of notes within a document rather than the meaning of the notes, requiring the user to manually associate notes by physical location within the electronic document. Because of this limitation, when a user wishes to associate a segment of the recording with an earlier note, the user must navigate to the page and location in the existing set of notes, presenting a serious inefficiency with lengthy notes. This system is also limited with regard to real-time augmentation of previously entered notes during recording, since the later notes will be time stamped with the time they were entered rather than with the time of the earlier material to which they relate or are relevant, lacking any automatic index linkage to the earlier material. As with U.S. Pat. No. 4,841,387, this system

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~~requires manual entry of notes, does not standardize the process of note taking nor provide any systematic means of observation, description, or assessment, does not combine systematic assessment with generation of indexes, does not provide a means for quantitative rating of observed events, and does not provide a means of retrieval and playback of recorded materials combined with systematic re-assessment or monitoring.~~

~~U.S. Pat. No. 5,172,281 discloses a system that supports an operator in manually correlating previously recorded video material with a standard text transcript for the purpose of generating an index that can then be used by software that searches text and finds associated video indexes. This system has no capacity to operate in real-time situations. It does not provide means for automated definition of segments of recorded material, nor does it provide an automated means of generating the actual indexes. It searches the text material only based upon operator entered key word comments, and is unable to take advantage of all the information in the original text. It is subject to the problem of specific comment words being used for more than one indexed timecode, requiring the operator who generates the indexes to keep track of and exercise judgement about the choice of comment words, a significant weakness because it does not provide a means of handling multiple occurrences of index key words in the transcript material.~~

~~U.S. Pat. No. 4,924,387 discloses a system by which a stenographer can control a video camera so as to stenographically record a deposition while simultaneously operating a video camera and recorder. This system's main objective is to provide a system to accurately record a deposition, not to efficiently and precisely locate and present specific passages of the videotape deposition. It provides a limited indexing structure since the stroke record made is intended to be a verbatim transcription of the verbal testimony made in a courtroom, rather than any systematic observations or assessment of the proceedings in the courtroom.~~

~~For all these systems described above, the user's ability to index notes or comments to the recording is entirely controlled through the indicia, or notes, the user has manually entered in a document. For both real-time and post-processing, these systems require the user first to process mentally the recorded events and then generate and enter text to create notes, subjecting the system and its indexes to individual user variance in generating the text content. No method is suggested for facilitating or enhancing a user's personal note-taking style or accommodating the note-taking functions towards more standardized and systematic observation and assessment applications. In all these systems, no method is explicitly suggested for handling the case of repetition or extension of certain events or activities in a~~

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~~single recording or across multiple recordings, using a common indicia for related events or phenomena.~~

Existing systems support some forms of indexing of recorded signals in a variety of ways. European patent application publication EP 0 495 612 by Lamming discloses a computer-based note-taking system integrated with an audio or video recording system. The computer presents a document editor style user interface to the user who either creates a new document or retrieves an existing document to which the user adds notes as a recording is made or played via the integrated audio or video system. As the user enters each note (mark or indicum), the indicum is added to the document and it is time stamped and stored in an information-to-time-stamp index. The time stamps are not visible to the user; they are stored with the computer's internal representation of the indicia entered by the user. A video-frame time stamp function time stamps time code data received from the audio or video recorder and creates a time stamp-to-time-code index. A browser function permits the user to retrieve sections of the recording using the indicia directly by selecting the indicia. The browser looks up the indicia in the first index to retrieve the time stamp, and looks up the time code of the recording in the second index using the time stamp, playing the section of the recording in the area indicated by the time code. EP 0495 612 also discloses how time stamping the indicia may be applied to creating topic or key word data. By entering new, separate indicia spatially near a previously entered indicia that is a key word or topic whenever an idea or speaker or topic applies to the previously entered indicia, later selection of all of the marks spatially associated with a topic will result in all sections of the recording indexed by the time stamps of the respective indicia to be replayed.

U.S. Pat. No 4,841,387, entitled "Arrangement for Recording and Indexing Information" and issued to Rindfuss, discloses a system for recording information relating to an event on a recording medium, such as an audio or video tape, and for indexing positions of handwritten notations made on a touch sensitive device and concerning the event to positions on the recording medium in order to allow the user to identify portions of the handwritten notations for which review of the correlated material on the recorded medium is desired. In the recording mode, the device makes an audio recording of the event on a standard cassette tape. Simultaneously, the electronic touchpad senses the position of the user's handwritten notes on the writing surface, and provides this information to the microprocessor which correlates the record of the positions of the handwritten notations on each page with the position of the recorded information on the audio tape at corresponding instants in time. Real-



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time constrained correlation vectors representing rectangular areas of the display surface each containing a cohesive group of handwritten text are each combined with a tape position that correlates to the instant in time the handwriting within that area began.

U.S. Pat. No. 4,425,586 issued to Miller discloses a system that combines a video tape recorder with a computer in such a manner that these two components each automatically record and display where related information is stored in its own mechanism as well as in its counterpart mechanism, allowing the user to determine the location of all the corresponding data stored both on video tape and on a storage medium such as a diskette, by examining only one storage medium. Notes about the recorded event or document may be entered onto the diskette along with the automatic entry of the corresponding reel number and frame number of the video record and diskette and file address number of the computer storage medium. Another feature disclosed is the capability of the system to enter and display the time and date on both the video tape and diskette recording mediums as well as on both video monitors along with the data address location information.

U.S. Pat. No. 4,924,387 issued to Jeppeson discloses a computerized court reporting system which provides for periodically annotating the stroke record made by the user of a court stenographic machine with a time stamp from a system clock while simultaneously sending a time stamp to a recording system making a video and audio recording of the testimony. The logic of a control system determines automatically when to time stamp the stroke record and permits the user to trigger a control function to annotate the video recording with automatic "on the record" and "off the record" messages with associated time stamps.

U.S. Pat. No. 5,564,005 issued to Weber et al. discloses a general system providing means for the user to first create a "time zone" correlated to a recording of an event, and then to flexibly enter into the time zone information relevant to the event, addressing some of the disadvantages of the systems described above.

These real-time data correlation and access systems have similar disadvantages. In the case of U.S. Pat. No. 5,564,005, the system does not automatically generate meaningful indica at the time the "time zones" are established by the actions of the user. Rather, information about the events correlated to a time zone is entered later, in the form of handwritten strokes, or may be generated and entered in real-time, subject to the conceptual and processing speed limitations and variance of a user's abilities. Therefore, the primary initial index guide to the meaning of the events within a time zone are the temporal characteristics of the time zone, augmented at the time by the memory of the user. In all

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these systems, no method or user interface design is explicitly suggested for handling the case of repetition or extension of certain events or activities in the recording, using a common indica for events or activities thereby related but occurring at different times, thereby facilitating or enhancing a user's personal note-taking style or accommodating the note-taking function to a variety of applications. For all except U.S. Pat. No. 5,564,005, the user's ability to index notes to the recording is entirely controlled through the indicia, or notes, the user has entered in a document, since the time stamps or position captures are those made at the time the notes are entered. Those systems assume, therefore, that the time of entry of a note sufficiently corresponds with the time or positions of the recording to provide an adequate index into the recording, requiring the user to mentally process the ongoing real-time events and within a certain time variance generate and enter the note. In the case of U.S. Pat. No. 4,924,387, this provides an adequate indexing structure since the stroke record made is intended to be a verbatim transcription of the verbal testimony made in a courtroom. In the case of EP 0495 612, however, where a verbatim transcription of the event may not be the note-taker's intention, such an assumption does not allow for the later, real-time augmentation of previously entered notes, while still recording, with additional notes related to the previously entered notes, since the later notes will be time stamped with the time they were entered rather than with the time of the material to which they relate or are relevant. In the case of the system disclosed by Rindfuss, notes may be entered later, but the later-entered notes will be correlated with the position of the tape at the time the later they relate or are relevant. In the case of the system disclosed by Miller, notes addressed to the diskette record of the event at a later time are entered entirely during a post-processing phase and not during the real-time recording of the event. In some of these systems, neither time stamps nor tape positions are visible to the user and so the temporal or spatial context of the entered indicia is not available to the user to enhance the retrieval function. In addition, in EP 0 495 612 the function provided for creating topic or key words from the entered indicia may be practically limited to one display "page" or screen unless the user reenters the topic or key word on a second screen or scrolls between screens to add a mark to a previously entered topic or key word. As with augmentation of notes in general, there is no facility for associating a key word or topic name created at a later time with notes entered earlier.

Existing post-processing (non-real-time) annotation systems in the field of post-production video editing provide for the creation of annotations about scenes correlated with "in" and "out" time codes identifying the scenes on a video recording. U.S. Pat. No.

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5,218,672 is an example of such a system. It is disclosed there that scene descriptions may be revised after initial creation, but the correlation of the annotations are confined temporally to the identified scenes.

In the post-processing system for the correlation of legal depositions with video recordings thereof disclosed in U.S. Pat. No. 5,172,281, a time code number is assigned by an operator of the system to both the computer transcript and the videotape segment where each question and answer passage begins, requiring manual time code entry. The location of individual words in the transcript may also be correlated with their corresponding position in the video recording, but there is no such result during the real-time process. In addition, the system does not appear to provide for the entry of notes or annotations.

Thus, despite~~Despite~~ the number of such prior art methods, ~~a need~~there exists a need for ~~ana recorded~~ information system that will digitally record events, ~~proecesses, or other~~ observable phenomena, ~~and simultaneously, efficiently, and accurately and automatically~~ generate informative ~~indexes~~indica that are correlated in real-time, with minimal interference to the ~~recording of the events without affecting an~~ interviewer's or observer's ability to take notes or assess the flow of events. ~~There is a more general need for systematic, structured, or standardized observation and assessment measurement methods, and there is a need to generate standardized, systematic, and quantitative indexes that are less subject to individual variance and which can be used between and among recorded information pertaining to different individuals or events so that comparisons and other analyses can be made.~~ Furthermore, ~~it~~It would be desirable to have a system that allows subsequent ~~annotation offor~~ annotating an indexed digital recording of information in such a manner that the annotation did not disrupt the standardization of the index or otherwise adversely affect the ability of one set of recorded information in a standardized index key to be compared to another set of recorded information ~~that uses~~having the same standardized index key.

There is also a need to generate a standard set of indexes that are not subject to individual variance and which can be used between and among recorded information pertaining to different individuals or events so that comparisons can be made. In the case of video and audio logging tools, exclusively post-processing systems are inadequate for generating notes and relationships between recorded segments, and are time consuming because they require review of the entire tape in order to generate an index. Automatic indexing of video and audio notes by system time stamping of key- or handwritten strokes or automatic detection of speaker voice changes does not provide adequate context markers for

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the recorded signals or does not permit user control of the amount of detail to be captured.  
For example, an index created on the basis of speaker segmentation of the material would tell  
who was speaking but not the substance of the talk. Establishing time zones through the  
action of a user does not directly generate indica containing information regarding the events  
within the time zones.

## SUMMARY OF THE INVENTION

### OBJECTS AND ADVANTAGES

Accordingly, it

It is an object and advantage of the present invention to combine systematic,  
standardized observation and assessment using pre-defined descriptors or measurement items  
with simultaneous recording to automatically generate meaningful indexes for the recording  
in real-time. Additional objects and advantages are:

- to provide a system and method that supports the generation and storage of new  
descriptor or measurement items with rating scales for subsequent use in systematic  
observation and assessment;
- to provide a system and method that can import and store a set of pre-defined  
descriptor or measurement items, such as an existing questionnaire or set of rating scales, for  
subsequent use in systematic observation and assessment;
- to provide a system and method that uses pre-existing descriptor or measurement  
items to structure the observation and assessment of events;
- to provide a system and method that uses measurement items that employ  
quantitative rating scales;
- to provide a system and method that efficiently creates an index for any type of  
recording by fully automatic correlation with the use of pre-existing descriptor or  
measurement items;
- to provide a system and method that stores recorded material in digital form in  
centralized electronic storage;
- to provide a system and method that stores descriptions or ratings of observed and  
assessed events or phenomena in centralized electronic storage;
- to provide a system and method that allows unlimited repeated use of any  
particular pre-existing measurement item — in other words, an observer can repeatedly assess  
or rate a phenomenon or a recurring event using the same measurement item;

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~~—to provide a system and method that allows unlimited concatenation of indexed recorded material when one or more phenomena or recurring events are repeatedly assessed using the same measurement item;~~

~~—to provide a system and method that can use any part or parts of the content of preexisting descriptor or measurement items as index labels or key words; —to provide a system and method in which a standard index, based upon a specific questionnaire or measurement instrument (i.e., a set of measurement items), can be applied across multiple recordings;~~

~~—to provide a system and method that can search, sort, and/or retrieve recorded materials based upon meaningful words or combinations of words from the full text of the descriptor or measurement items used in the index;~~

~~—to provide a system and method that can search, sort, and/or retrieve recorded materials based upon numerical ratings from standardized observation and quantitative assessment using measurement items with rating scales;~~

~~—to provide a system and method that permits assessors to re-order recordings of events and compare similar events from different subjects on the basis of the associated measurement items in order to investigate possible relationships and/or trends not previously discernible;~~

~~—to provide a system and method that allows a user, such as a student or trainee, to view and/or review prior assessment results, i.e., descriptor or measurement item assessment choices, by the same user or by a different user, in parallel with playback of the recording of the observed and assessed events or phenomena, allowing for efficient use of actual assessment for teaching or training;~~

~~—to provide a system and method that allows playback of recorded materials with the prior selections of descriptors or ratings hidden from display;~~

~~—to provide a system and method that allows re-assessment or re-rating during playback so that rater efficiency, accuracy, and reliability can be measured;~~

~~—to provide a system and method that allows multiple users to make ratings based upon a single original recording, and that allows multiple users to playback and rate at the same time;~~

~~—to provide a system and method that supports comparison of assessment results or ratings across multiple raters, subjects, events, or geographical sites, for analysis, teaching, monitoring assessment, or other research purposes;~~

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~~—to provide a system and method that can automatically compare ratings to make it easier to teach, monitor, and conduct research;~~

~~—to provide a system and method that allows unlimited manual addition of index points and labels during playback; and invention to provide a system and method for digitally recording information about an event or individual and generating a standard set of indexes for this information.~~

It is a further object of the invention to provide a system and method for annotating an indexed, digital recording of information without changing the standardized index markings in such a manner that would adversely affect the ability of one set of recorded information in a standardized index key to be compared to another set of recorded information having the same standardized index key.

In accordance with a preferred embodiment of the present invention, the invention employs a system that includes: (a) means for presenting a subject or operator with a measurement item; (b) a recorder that records and stores observations of events associated with the measurement item in a digital recording that includes a data track sequenced by a time track of time data; and (c) indexing software that enters an index mark based on said time data into an editable database denoting said measurement item. Any annotation, cross referencing, or entry of notes will occur in the database in association with the time data track index without affecting the index.

In use, the testing system of the invention includes the following steps: (a) presenting a measurement item to a subject or operator; (b) digitally recording on a digital storage medium at least one event associated with said measurement item, said digital recording having a event data track of event data sequenced by a time track of time data; (c) indexing said digital recording by entering time data related to said event into a field on computer database along with an identifier of said measurement item; and (d) optionally, augmenting said computer database by adding information to said database that relates to said event field without changing the relationship of said time data to said event data.~~—to provide a system and method that allows assessors and others using a “test and response” method of investigation greater note-taking and annotation efficiency and flexibility than was previously available.~~

The system and method of the invention permit measurement items to be associated to observed events, the responses recorded and indexed by measurement items onto a computer-based database for review, annotation and augmentation of diverse information

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without affecting the time sequencing of the recorded data or the ability to replay a portion or all of the recorded events. Such a system will allow assessors and others using a "test and response" method of investigation much greater note-taking and annotation flexibility than was previously available with prior systems. The system of the invention also permits assessors to re-order recordings of events and compare similar events from different subjects~ on the basis of the associated measurement items in order to investigate possible relationships and/or trends not previously discernible.

———Further objects and advantages of the invention will become apparent from a consideration of the drawings and ensuing discussion.

### SUMMARY OF THE INVENTION

———The present invention combines systematic observation and assessment using predefined descriptor or measurement questions or items with simultaneous digital recording in order to automatically generate meaningful indexes that support improvements in efficiency, consistency, and accuracy in retrieving and utilizing the recorded material. Based upon the contents of the measurement questions or items, including any qualitative or quantitative descriptions or numerical rating results from use of the descriptors or measurement items, the indexes can readily be further processed and manipulated to additional advantage. The invention provides a method for access and manipulation of digital recordings of events by use of these pre-entered or pre-existing measurement items as meaningful index information designators such as key words, labels, item numbers, or numerical ratings. Such a method is particularly used for processes relating to systematic interview or assessment methods, including the training and monitoring of interviewers or assessors and the storage, retrieval, analysis, and other manipulation of recordings.

### BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, closely related figures have the same number but different alphabetic suffixes.

Figs. 1A and 1B show an example of a measurement item from the World Health Organization Schedules for Clinical Assessment in Neuropsychiatry.

FIG. 1 is a flow diagram of the recording and indexing functions of the present invention.

FigFIG. 2 is a generalized blockflow diagram illustrating the configuration of the

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systematic assessment and simultaneous recording and automatic indexing functions of a preferred embodiment of the present invention.

Figs. 3A and 3B illustrate further details of the systematic assessment and simultaneous recording and automatic indexing functions of a preferred embodiment of the present invention. Fig. 4 is a block diagram illustrating the configuration of the search, sort, retrieval, of the playback, and manipulation editing functions of a preferred embodiment of the present invention.

Fig. 5 is a block diagram illustrating the configuration of post-processing systematic re-assessment functions of a preferred embodiment of the present invention. Figs. 6A and 6B show screen shots of a preferred embodiment of the present invention.

### DETAILED DESCRIPTION

The present invention is a means and method for automatically generating meaningful indexes for recorded material. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one of ordinary skill in the art that these specific details need not be used to practice the present invention. In other instances, well known structures, interfaces, and processes have not been shown in detail in order not to unnecessarily obscure the present invention.

A preferred embodiment of the invention will now be described herein below with reference to the drawings. To explain clearly, explanation will be made in accordance with the following order:

- (1) with respect to conducting an assessment interview;
  - (2) with respect to playing back an indexed interview;
  - (3) with respect to searching and retrieving indexed materials;
  - (4) with respect to re-assessing a prior assessment interview.
- (1) Conducting an assessment interview

Figures 1A (item) and 1B (rating scale) illustrate a typical measurement item from the World Health Organization (WHO) Schedules for Clinical Assessment in Neuropsychiatry (SCAN). In general, measurement items typically are composed of: 1) definition of a phenomenon of interest; 2) instructions regarding observation of the phenomenon; and 3) a quantitative rating scale. Suitable measurement items can vary over a wide range and will depend on the information sought from the test subject and the type of



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analysis intended. Examples of analysis include behavioral responses to audio and/or visual information (questions, directions, lights, sounds, etc.), physical examinations of laboratory specimens, oral depositions of witnesses, etc. The SCAN represents a detailed instrument for clinically based, standardized psychiatric assessment of psychopathology phenomena. The SCAN contains over 1,500 measurement items, each of which is composed of at least an item number 102, an item title 104, and an item rating scale 120 (Fig. 1B) with rating scale text 122 and rating scale quantitative ratings 124, and optionally an item definition 106, an item glossary entry 108 providing further definition, suggested probes 110 (questions) for interview use, and other instructions 112, all of which combined are referred to as the "content" of a SCAN measurement item. Each measurement item as a whole with its constituent content may be considered as an object with respect to its function for conducting an assessment interview and indexing a simultaneous recording.

Figure 2 shows a generalized block diagram of a preferred embodiment of the present invention. In this typical architecture, the system display presents a set of predefined measurement items 202 to the user, while simultaneously processing and digitally recording the observable event to be rated, in this case the psychiatric interview 204. As the user carries out systematic observation and assessment with selection of a measurement item 206, optionally generating measurement result data by using the rating scale of the measurement item, the system automatically defines a segment of recorded material 208, based upon the repeated 214 selection by the user of measurement items from the displayed set over the course of observation and assessment. The end of the previous segment and the start of the next segment is defined when a measurement item is selected. For the first segment, no prior segment end is defined, and the start of the segment is defined by the start of the digital recording. Each segment is indexed to the currently selected measurement item that defines the start of the segment 210. The combined segment definition and segment indexing functions 212 are carried out in the background without user observation. The digital recording, measurement result data, and index information are stored in a data base 220. The index information thus includes the text content 102, 104, 106, 108, 110, 112, and 120, of each associated measurement item and the rating scale 120 results 122 and 124, which can be used as a common set of key words, labels, and quantitative attributes to identify index entries and allow retrieval of diverse recorded event data from different subjects under a common framework. The resulting assessment forms a data base file that can be stored, shared, or integrated into other digital records as needed by the user.

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Figures 3A and 3B illustrate further details of the systematic assessment and simultaneous recording and automatic indexing functions of a preferred embodiment of the present invention. The system provides the user with a set of pre-defined measurement items and means for navigation and selection 302. Simultaneously, a process of digital recording occurs 304. When a measurement item is selected 306, the system automatically gets lower-level address information such as a time code to identify the start of the recording segment 308, and links the segment start address with the current measurement item 310.

While these addressing and linking processes occur in the background, the user assesses the subject, optionally choosing to use the rating scale from the current measurement item to generate measurement rating data 312. When the next measurement item is selected by the user 314, the system automatically gets lower-level address information to identify the end of the recording segment 316, creates an index item by linking recording segment start and end identifiers to the employed measurement item, along with any measurement results data 320, and then stores the index item in the data base 220. If the measurement item was previously used, and therefor there is an existing index item 324 using that measurement item, then the recording segment start and end identifiers are appended 328 to the existing index item and stored in the data base 220.

Figure 4 is a block diagram illustrating the configuration of the query, retrieval, manipulation, playback, and indexing functions of a preferred embodiment of the present invention. One means of retrieving recorded material is through use of the pre-defined measurement items 402 that were used in the creation of the index items. From the display, the user can view and select a measurement item. Likewise, the data base can be queried by searching the index items for key words from the content of the associated measurement items 404. The data base can also be queried by searching for specified assessment results 406. From these actions, either singly or combined 408, the system automatically generates a query 410 to the data base 220 that retrieves 412 the associated segment or segments of recorded material for further management 416. Any search results can be sorted or filtered using standard means, and can be generalized to search across multiple subjects and multiple assessments using standard means. Retrieved recorded material can be selected and manipulated for output to another system or file, or can be played back with standard functions 418. During playback, additional indexing can be performed. If further indexing is desired by the user 420, the system supports a choice 422 of creating and using new index labels 424 or using existing measurement items 426. The indexing process 428 described

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earlier associates these index elements with recorded material, and the results are stored 430 in the data base 220.

Figure 5 illustrates the configuration of post-processing systematic re-assessment functions of a preferred embodiment of the present invention. A re-assessment mode 502, re-assessment subject 504, and an existing assessment 506 can be selected 502, allowing the observation through playback of the recorded materials association with the existing assessment 506. The set of pre-defined measurement that was used to carry out the original assessment is displayed 508, allowing its use for navigation and selection of specific indexed segments of recorded materials. Standard playback functions are also available 512. The materials observed through navigation and playback can then be re-assessed using the set of pre-defined measurement items 514, and the re-assessment results stored 516 in the data base 220. Standard management functions can then be used to process the stored data 520.

Figures 6A (assessment) and 6B (playback) illustrate a preferred embodiment of the present invention as implemented in a working software program ("CliniMetrica"). For assessment, a set of pre-defined measurement items is displayed 602, from which the user can select the current measurement item 604. The rating scale text 608 and quantitative values 606 allow systematic rating. Digital audio and video recording can be started 620, and will be automatically indexed in sequence with the selected measurement items. For playback, the list of measurement items used in the assessment is displayed 632, allowing retrieval of the correlated segment of recorded material, for playback via a standard set of playback controls 640. Further, the indexed recorded material can be retrieved through text search of all of the measurement item, including rating scale, text 638. The recorded material that is played back can be re-assessed 650. The invention is described in detail invention is described with reference to inquiries from an assessor and responses made by an interviewee during an oral interview assessment. It will be understood that the description is equally applicable to any form of systematic assessment or observation by verbal, visual, audio, or physical method (e.g., questions or directions whether presented orally or in text printed form, mental or physical tests or testing, use of software or hardware, etc.) and any form of response by the subject, human or other, of observation (verbal, nonverbal, or physical response) with mere changes in semantics to describe the particular form of test and response.

A general testing system according to the invention includes the following steps: (a) presenting a set of pre-defined measurement items item to a subject or operator for use in structuring and carrying out the observation and assessment of events or phenomena of

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~~interest; (b) simultaneously making a digital recording of one or more aspects of the observed events or phenomena; (b) making a digital record on a digital storage medium; at least one event associated with said measurement item, said digital recording including record having an event track of event data sequenced by a time track of time data; (c) automatically indexing said digital recording by automatically entering time data and an identifier relating to the current selected measurement item into a record in fields on a computer data based database; and (d) optionally, augmenting said computer data based database by adding information to said data based database that relates to said measurement items or said digital recording event field without changing previously established indexing relationships and data base records the relationship of said time data to said event data.~~

An interviewing assessment system according to the invention includes a personal computer having: (a) an output communication subsystem that allows communication with an interviewer or interviewee or interviewer so that pre-defined measurement items can be presented and selected; (b) an input subsystem for the interviewer or interviewee to respond to the measurement item communications to generate assessment data results; (c) a recording subsystem that simultaneously makes a digital record of the audio, video, physiologic, or other types of recordable event data from either or both of the interviewer's and output communications as well as the interviewee's behaviors and responses, with a data track of said event data synchronized to by a time track of time data; (d) an indexing subsystem that automatically generates correlation entries that define time segments of the digital recording based upon the selection or presentation of successive measurement items, and links these time segments to the measurement items, thereby creating a meaningful index for these segments of digital recording by use of the contents of the correlated measurement items and any quantitative measurement rating results; and (e) a digital storage retrieval subsystem that uses the measurement item based index to retrieve segments of recorded material for playback, analysis, editing, annotating, re-rating, or other related purposes a digital storage subsystem that allows the digital record to be stored for playback and editing; and (e) a computer with database software that can generate a database event index record based on said time data for each measurement item.

The means for presenting the subject or operator with measurement items can take many forms, depending on the type of measurement item involved with the assessment. The system and its method of use is most easily described here in the context of an interview between a subject and an interviewer using a computer to display a series of measurement

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~~item~~ questions to the interviewer as a guide for the interview. ~~At the same time, the~~ The interview is recorded by a ~~audio or video~~ recorder (preferably digital) that includes a data track synchronized by a time track of time data. As the interviewer moves from one question (~~i.e., measurement item~~) ~~to a new question~~ to another via input ~~into~~ the computer, this ~~question-switching~~ the input is an act that causes the ~~data base (either from software or hardware functions)~~ database to record the time data (preferably a stop data bit for termination of the preceding ~~time segment of recording~~ and a start data bit for beginning the next ~~time segment of recording~~) and an associated identifier that ~~links the time segment of recording~~ pertains to the new question (measurement item), ~~thereby generating an index entry.~~

As those skilled in the art will appreciate, the indexing act can be done in an active interview situation, by the interviewer, as questions are posed. The indexing can also be done in passive situation, where the operator is observing but not necessarily actively interacting, by the operator entering ~~inputs~~ an input into the computer from a list of predefined topic items (measurement items) during actions by the subject of observation. Either method will generate a ~~data based~~ database of event data that is indexed by a series of ~~measurement item-based~~ identifiers that can be sorted and retrieved for selective retrieval and playback of the events.

~~The preferred~~ Preferably, the software embodiment of the invention for a personal computer ~~will have that has~~ the capability to: (i) communicate ~~pre-defined~~ inquiries to the interviewee directly or through an interviewer in a systematic manner; (ii) provide a rating scales or methods associated with or part of the pre-defined inquiries scale or method by which said inquiries can be rated ~~or applied for the purpose of describing said interviewee;~~ and (iii) ~~automatically generate~~ provide an index in the form of retrievable, index marks associated with the ~~pre-defined~~ inquiries. A personal computer is used to communicate the inquiries and ~~at the same time then to~~ capture and digitally record or control a recording device that records the interviewee's responses to form a digital record of indexed inquiries and indexed responses. ~~As those skilled in the art will appreciate, any type of computing device could be used to provide these functions, including customized or programmable hardware that provides functions described above as provided by software.~~

~~If digitally recorded~~ During later playback and if responses are to be further indexed ~~during later playback~~, the system can also insert additional response index marks and the identifiers for the ~~index marks~~ them into the digital record so that digital materials are further indexed for retrieval. For example, in reviewing an earlier responses are digitally marked for

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retrieval. An assessor may also insert additional inquiry index marks into the recorded  
~~interview, an assessor may wish to employ pre-defined measurement items not used~~  
~~originally in interview, to further assess or rate the interview. In addition to use of pre-defined~~  
~~measurement items which provide meaningful text content that serves as index labels or key~~  
~~words, new index, Index marks can be placed at any point in the recording with manual entry~~  
~~of a label or key words. Furthermore, if the user wishes for example to study or analyze~~  
~~communication and response patterns, new measurement items could be created and stored~~  
~~for repeated use. Preferably, an "inquiry" measurement item could be created, stored, and~~  
~~then inserted at each location of interest~~but an inquiry index mark is preferably inserted  
~~where a specified data item inquiry is being communicated, and a "response" measurement~~  
~~item could be created, stored, and index mark is inserted where the response is made. The~~  
~~inquiry and response index marks are desirably standardized and relate to the systematic~~  
~~content of the inquiry or the response.~~

The invention is conveniently explained in the context of an interview under the WHO Schedules for Clinical Assessment in Neuropsychiatry (SCAN). These schedules represent a detailed instrument for clinically-based, standardized psychiatric assessment of psychopathology phenomena. ~~The SCAN contains over 1,500 measurement items, each of which is composed of at least an item number, an item title, and an item rating scale, and optionally an item definition, an item glossary entry providing further definition, suggested probes (questions) for interview use, and other instructions, all of which combined are referred to as the "content" of a SCAN measurement item. An example measurement item from the SCAN is shown in Figs. 1A and 1B. The SCAN is a widely recognized and used international standard, having been translated into over 25 languages. It will be understood by those skilled in the art that the techniques applied to a SCAN assessment would be applicable to other types of assessment instruments, physical examinations, or other physical phenomenon whose analysis is aided with a recording of sights, sounds, physiology, and/or other domains of observation with only minor semantic differences that describe the same essential types of events.~~

~~Using the present invention to conduct a SCAN psychiatric~~During an assessment  
~~interview with a human subject, real-time selection by~~of the interviewer of a relevant SCAN  
~~item in the natural course of the interview, observation, and assessment of clinical~~  
~~phenomena~~events automatically generates a series of time-based stamped inquiry index entry  
~~linkmarks that allows use of the SCAN items~~serve as an informative indicum for the

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~~simultaneously recorded data (e.g., any of audio, video, physiologic).~~ The time-stamp index marks (time stamp plus identifier) are stored in data-based database fields with time data that is correlated to a sequence of event data in the recording of the events. The resultant set of time stamp index marks then provides a general index structure which can be used to further support, independently of the real-time process, a flexible note-taking structure and user interface that complements diverse personal note-taking styles and application needs.

→ Notations and annotations in the form of text, sound, video, or other data can be entered into the data-based database as separate fields of information without affecting the relationship between the time stamp index mark and the recorded data associated therewith. Thus, the use of digital index marks of an event recording in an editable data-based database provides assessors with the ability to generate assessment records rich in diverse content. When coupled with standardized assessment inquiries (e.g., a list of standard interview questions) and a data-based database field that identifies each inquiry by a standardized descriptor for each inquiry, this rich assessment record can be used as a basis for comprehensive comparisons on a rich diverse content.

In the case of assessment interviews in which there is no pre-existing set of ~~standardized-measurement items~~ (questions, definitions, inquiries, instructions, directions, or other tasks), an important feature of the present invention is the ability for the assessor or another individual (e.g., an interview designer) to generate a set of items prior to the event to be observed, assessed, and recorded. ~~This supports the process of developing and develop a new set of standardized inquiries for investigating new issues.~~ This set of items can be used and re-used as real-time index information designators which can later be used as standard access mechanisms into both the notes and the correlated recorded signals. These new inquiries, e.g., key words, labels, or any other pointer to information, can identify specific concepts in the user-produced information ~~to for~~ which the user wants to have later access. An information designator is treated as an object that ~~can be~~ easily created and reused. ~~This and this~~ novel implementation both in the user interface and data structure ~~of for~~ the present invention provides a flexible and powerful indexing tool ~~for into~~ the recorded signals in addition to the access provided by the recorded medium's address ~~parameters parameter~~.

In an environment where a recording of events is being made simultaneously ~~with a the rating of these events~~, the interviewer has limitations, ~~due to limitations of human cognitive abilities~~, on what actions can be taken or ~~what additional items can be considered~~ as the interview is in progress. The present invention produces a digital data-based database of

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indexed inquiries and responses that can be used to organize the assessor's notes, originally written in free text or graphical form, but later entered into the ~~data-based~~database with minimal restriction as to the amount of that information or when it is entered. The inquiry and/or response index marks allow the assessor's notes to be correlated with the recorded signals of the event. Further, the present invention provides the assessor with the ability to modify any notes that were previously entered without regard to when the modifications are made or where they are located on the recording medium.

The invention recognizes, moreover, that the temporal or spatial sequencing of information is itself often a significant clue as to the content of the information and may aid a user in recalling memories or in retrieving recorded information from a perceived event. The inquiry and response index marks of the present invention provide a mechanism for the user to control the playback sequence and thereby view the index with items sorted in, e.g., chronological order, type of inquiry (as denoted by the type of inquiry index encoded into the digital record), by type of response (also as denoted by the type of response index mark encoded into the digital record), as well as any other order desired by the assessor.

→ The system of the present invention is particularly effective for video and audio interviews where the events include a time sequence of responses by the ~~interviewee or test~~ subject. These events are recorded as a series of audio or video input data ~~segments~~ sequenced by a time track of time data. Because the amount of detail that may be captured for a particular time on an associated recorded medium is open-ended, a richer set of annotations may be ~~efficiently made by use of pre-defined measurement items~~made while the video is being digitally recorded in real-time than is typically allowed in previous analog systems. ~~This relieves the note-taker (i.e. the measurement assessor) of many of the pressures typically associated with taking interview notes in real time. The time sequence~~The time zone and reusable information designator object features provide for treating the event as a whole and ~~permithy permitting~~ later augmentation or modification of previously made notes. This relieves the note-taker of many of the pressures typically associated with taking interview notes in real time.

It is another significant advantage that the system of the present invention operates in both real-time and post-processing environments. This feature recognizes that ~~notetaking~~note-taking as a human activity is typically an interactive process. The output data structure (e.g., the ~~indexed-video materials~~)log, produced by the system of the present invention during a real-time note-taking session while the event is being recorded may be



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further modified and/or augmented by the same user or by different users during post-processing review sessions occurring in parallel or ~~serial~~serial~~ation~~. This facilitates and potentially reduces the time ~~required~~involved in the post-processing ~~sessions~~session.

A system for correlating event data being recorded in real time to event information entered into the system by a system user includes input circuitry connected to a user input device for producing signals indicating actions of a system user; output circuitry connected to a display having area for presenting images; and a processor connected for receiving the signals from the input circuitry, and connected for providing images to the output circuitry. The system also includes a digital recording device in communication with a digital storage medium for producing a plurality of signals indicating recorded event data about an event for storage on the storage medium. The recording device is currently producing the plurality of signals and indicating the recorded event data and is connected for simultaneously providing address data items to the processor of the system and to the recording device. The recording device stores the plurality of signals indicating the recorded event data on the storage medium so that a recording address value of each address data item provided by the address source indicates a portion of the recorded event data. The ~~systems~~systems also includes memory for storing data, including instruction data ~~that indicate~~indicating instructions the processor executes.

Stated another way, the system may be configured to operate in a post-processing environment so that an event that has already been recorded but not indexed is the event about which a log is constructed according to the present invention. The event that has already been recorded is digitally stored on a storage medium as a plurality of signals indicating recorded event data about the event. In this aspect of the invention, the system includes an output device for presenting the previously recorded signals thereon to the system user. This output device is in communication with the storage medium including the plurality of signals indicating recorded event data about the event. The output device is connected for providing a plurality of address data items to the processor of the system as user-requested address values; each address data item is a recording address value indicating a portion of the recorded event data. Preferably, the plurality of signals indicating the recorded event data includes the plurality of address data items, but the output device may itself generate them as the plurality of signals is being presented by the output device.

The system of the present invention permits a system user to interactively produce stored information that is correlated with an "address". The "address" refers to a

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~~sequence~~measurement dimension used to identify a portion of the stored information. When the stored information is being correlated with recorded signals, the address typically refers to the location of the recorded signals on the storage medium storing the recorded signals. However, the system of the present information is not limited to correlating information with recorded signals, and may be used in any situation where later access to the stored information would be facilitated by correlation with an address, and by having an access mechanism as provided by the "information designators". Generally, when the system user is producing a ~~data-based~~database of stored information, the address record will be time data taken from the time track of the recording of the events.

The computer-controlled system of the present invention uses common, readily available hardware components. For an assessment interview delivered via computer, the system includes a computer with an image display that will display questions or directions, an input that receives signals from a user interaction device, e.g., keyboard, digital tablet, microphone, camera, or other recording device that produces a data track synchronized by a time track. The display can present the ~~measurement item~~ questions directly to the subject or, alternatively, can display a series of questions to an interviewer/assessor who then presents the questions to the subject. Some act taken to move from one question to another generates the ~~data-based~~database time entry or start/stop time entries as well as the index identifier that pertains to the question.

Analog recording devices can ~~have their recordings~~be digitized, ~~or the observable events can be~~ or recorded directly as a digital recording that includes: (a) a data track of sound, image, or other event data that are synchronized by (b) a time track that includes time data correlated with event data. The use and existence of these two data tracks is typically transparent to the user of the equipment but can be read by a computer and used to generate ~~data-based~~database entries for each recorded event based on the time track data associated therewith from the digital recording.

The user interaction devices useful in the present invention may include any one of a variety of input devices controllable by a human user. For example, the user interaction device may include a pointing and gesturing device to indicate actions, gestures, and strokes such as those produced when making handwriting gestures. A stylus or other form of handheld pen are examples of a suitable user interaction device. Other pointing devices such as a mouse, ~~trackball, eye position, or brain activity electrical or magnetic patterns may also be suitable for indicating actions, gestures, and strokes.~~ or a trackball may also be suitable for

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indicating actions, gestures, and strokes.

The present invention is further understood by reference to FIG. 1 which shows a flow diagram of the recording and indexing functions of the present invention. A digital recording 1 of a series of events is made directly by a digital recorder or made into a digital formation 2 from an analog recording. The indexing system 3 is used to generate a database 4 of index items 5 based on measurement items 6.

Suitable measurement items can vary over a wide range and will depend on the information sought from the test subject and the type of analysis intended. Examples of analysis include behavioral responses to audio and/or visual information (questions, directions, lights, sounds, etc.), physical examinations of laboratory specimens, oral depositions of witnesses, etc. In the case of a behavioral examination, measurement items 6 can be generated in process 10 from a standard assessment instrument 7, open ended questions 8 and any other inputs 9 desired by the assessor. Preferably, process 10 is a simple system that is readily repeated. Suitable examples include a question outline or list.

Similarly, FIG. 2 shows a flow diagram of the playback and editing functions of the present invention. Digital data 20 made of an event sequence track of event data is synchronized by an associated time track of time data is played back 21 for audio, video, and/or physiological events. Preferably, new index items 22 are created during a post-processing playback and review phase but may also be created separately, for example as a pre-existing detailed set of measurement sub-items, or as additional notes during the original assessment process. Each index items is based on a link 23 between the time data in the time track with corresponding event sequence data and entered as index data 24 in a database. This database can include associated records that identify the index entries by a common set of labels, index attributes 25 or other identifier that allow diverse event data from different subjects under a common framework. The resulting assessment forms a database file 26 that can be stored, shared, or integrated into other digital records as needed by the assessor.

Although the foregoing disclosure relates to preferred embodiments of the invention, it is understood that these details have been given for the purposes of clarification only. Various changes and modifications of the invention will be apparent, to one having ordinary skill in the art, without departing from the spirit and scope of the invention.